Public Health England

Protecting and improving the nation's health

CANCER RESEARCH UK

Travel times and cancer

Impact of travel time on rates of treatment with radiotherapy

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Contents

Key message

Analysis of prostate cancer radiotherapy treatment rates showed that the percentage of patients receiving radiotherapy did not decrease with increasing distance to the nearest radiotherapy centre.

Executive summary

Prostate cancer is the most common form of cancer for men in England. Those with localised disease have the option of surgery or radiotherapy as both have similar survival outcomes. This means that men may make a treatment decision based on other factors, such as time spent travelling for treatment.

This pilot study investigated the relationship between rates of treatment with radiotherapy for prostate cancer and travel time to the nearest radiotherapy centre. The focus on radiotherapy was due to the multiple visits required which make travel time a larger issue.

No statistically significant effect of travel time on the proportion of patients receiving radiotherapy was found.

Background

Prostate cancer is the most common form of cancer for men in England, with over 40,000 cases diagnosed annually since 2013. Various treatments are available for prostate cancer, including:

- active surveillance
- surgery
- radiotherapy
- brachytherapy
- hormone therapy
- chemotherapy

Men diagnosed with intermediate-risk localised (stage 1 and 2) prostate cancer should be offered the choice of radiotherapy or surgery [1]. Analyses of recorded treatments indicate that this is probably happening. For example, men with stage 2 prostate cancer diagnosed in England in 2014 had surgery and radiotherapy with similar frequency: 2,258 (28%) had surgery and 2,899 (37%) had radiotherapy [2]. Some patients may

choose surgery as they feel reassured that removal of the prostate removes the disease, where others may choose radiotherapy due to the possibility of better Quality of Life (QoL) resulting from lower rates of incontinence and sexual dysfunction [3] [4]. Other factors may also influence the choice of intervention. These may include the amount of travel time required to attend a radiotherapy centre 20 to 35 times during a single course of treatment.

Methodology

This study investigated the relationship between rates of treatment with radiotherapy (excluding brachytherapy) for prostate cancer and travel time to the nearest radiotherapy centre. The expectation was that because of the travel demands of radiotherapy (attending a treatment centre daily for 4 weeks or more), patients living further from a radiotherapy centre may prefer surgery as a treatment option and that this would result in the rate of treatment with radiotherapy decreasing as the distance to a radiotherapy centre increased.

The study cohort comprised 60,361 prostate cancer patients diagnosed in England between 2013 and 2015, with stage 1 and 2 tumours – suitable for curative treatment. These were identified from the cancer registration database held by the National Cancer Registration and Analysis Service using ICD10 code C61.

The journey times by car to hospital were calculated using the Graphhopper Open Source routing engine on maps from OpenStreetMap [5] [6]. This approach is known to calculate optimistic travel times, resulting in the underestimation of times by roughly one quarter to one third on average, however we believe this is acceptable for examining trends at a population level.

Analysis looked at the relationship between the proportion of patients treated with radiotherapy within twelve months of diagnosis and:

- travel time to nearest radiotherapy centre
- difference in travel time to nearest radiotherapy centre and nearest cancer centre without radiotherapy services (additional travel time)
- whether the patient was diagnosed at a radiotherapy or non-radiotherapy centre

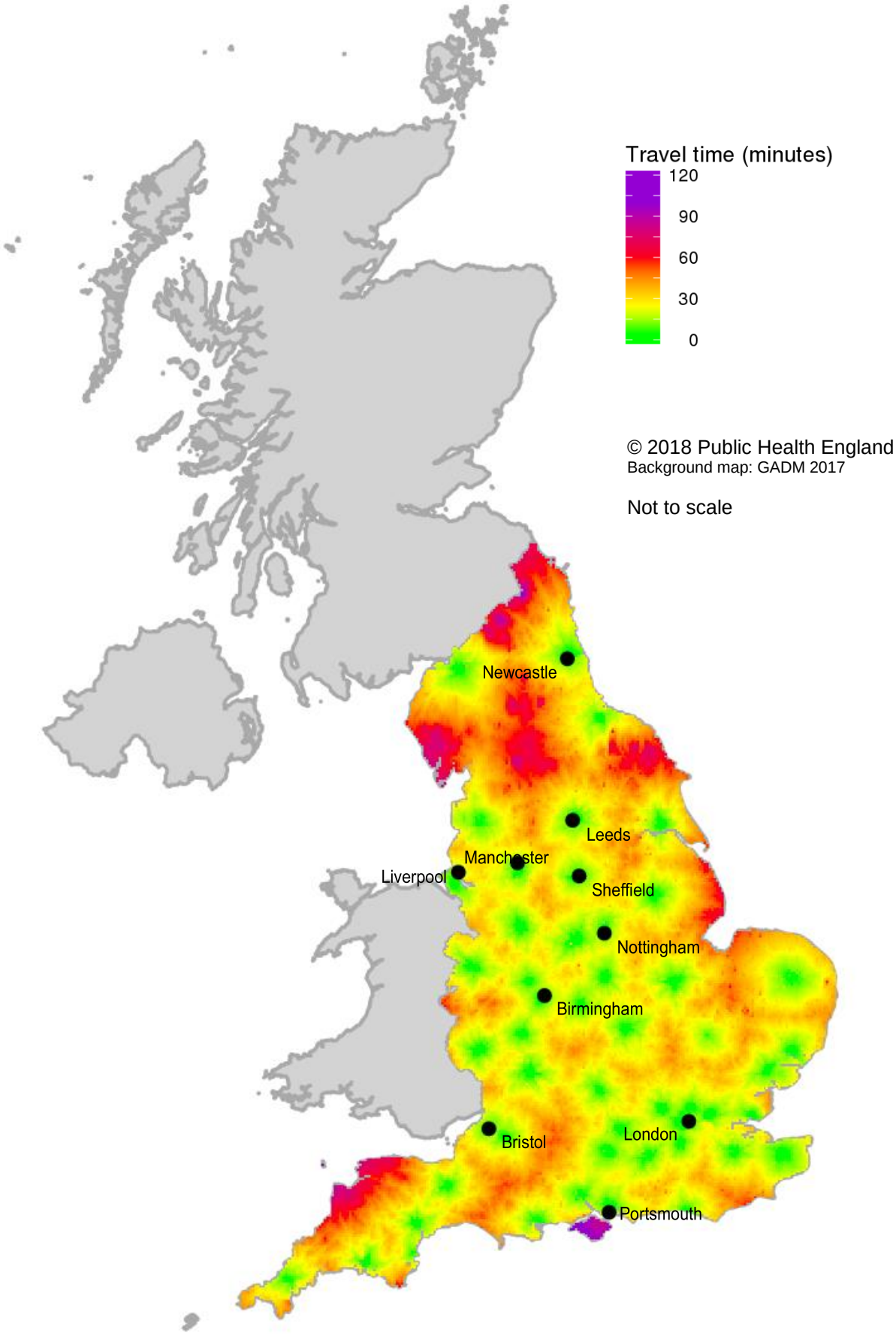
The relationship between travel time and the proportion of patients receiving radiotherapy as their first treatment was also explored. For each analysis we produced crude results and results controlling for potential confounding effects from age and deprivation, with deprivation specified as the population-weighted quintile of income-related deprivation from the English Indices of Deprivation [7]. Analyses were performed in R with plots generated using the ggplot2 package [8] [9].

Results

Travel times to treatment with radiotherapy

Currently there are 53 NHS Trusts that provide radiotherapy services in England, with 96% of our cohort within 45 minutes' journey by car and only 1.2% greater than one hour away as calculated using Graphhopper. A map of travel time to nearest radiotherapy centre is shown in Figure 1, with journey time represented by colour. A selection of cities has been added for reference purposes. Note that the green areas of short journey times correlate strongly with cities and population centres. There are more NHS Trusts that provide cancer services without radiotherapy and, as such, travel times to radiotherapy centres are longer than those to cancer centres for 71% of the cohort (not shown).

Figure 1: Graphhopper travel time to nearest radiotherapy centre in England, 2017



Relationship between travel time and proportion of patients receiving radiotherapy treatment

A *t* test was performed to compare the average travel time for patients treated with radiotherapy with that for patients not treated with radiotherapy. This showed no statistically significant difference between the groups; *p*-value = 0.35. Logistic regression also showed no statistically significant relationship between radiotherapy treatment and travel time to nearest treatment centre, *p*-value = 0.36, and multiple logistic regression revealed that the treatment rate was associated more strongly with age and deprivation than with travel time to nearest radiotherapy centre.

Figure 2 shows the proportion of patients receiving radiotherapy (solid blue line), with travel times to nearest radiotherapy centre in ten minute intervals. The multiple logistic model (red dash) is essentially flat, with a 30 minute increase in travel time corresponding to a less than 1% increase in the proportion of patients receiving radiotherapy.

Comparing the additional travel time for treatment at a radiotherapy centre with the proportion of patients receiving radiotherapy produced similar results. The t test showed no statistically significant difference in the average travel times of the radiotherapy and non-radiotherapy treated groups. Logistic regression showed no statistically significant difference between the average travel times of the radiotherapy treatment and non-radiotherapy groups. Figure 3 shows the proportion of patients receiving radiotherapy plotted against the additional travel times to nearest radiotherapy centre in ten minute intervals, with the regression model (red dash) again essentially flat.

Investigating the relationship between travel time and proportion of patients receiving radiotherapy as their first treatment produced very similar results (not shown). Logistic regression showed no statistically significant relationship between the proportion of patients receiving radiotherapy as a first treatment and travel time. Again, t tests showed no statistically significant difference in the average travel time of the radiotherapy treatment and non-radiotherapy groups.

Figure 2: Proportion of patients receiving radiotherapy vs travel time to nearest radiotherapy centre

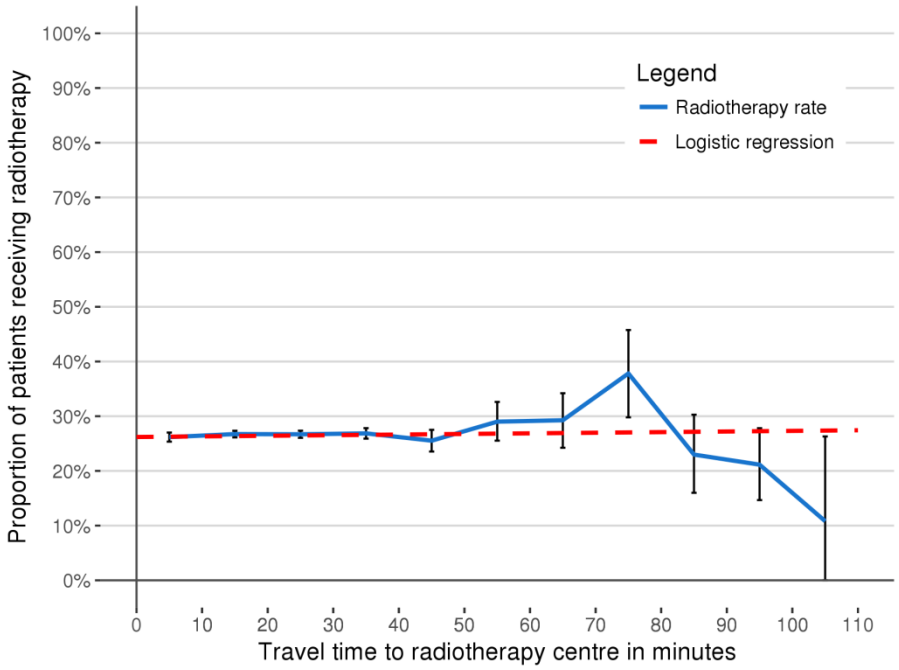
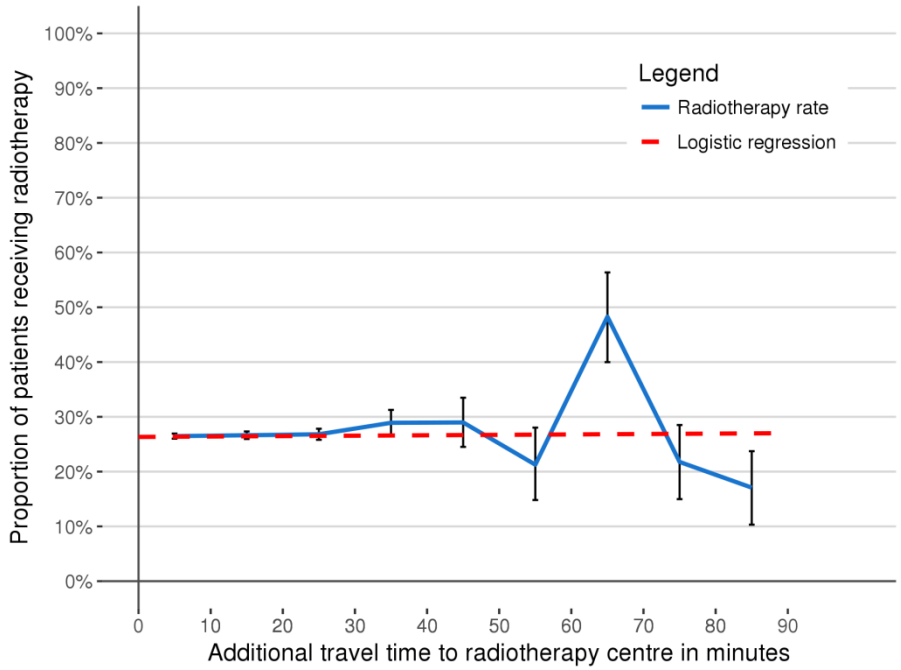


Figure 3: Proportion of patients receiving radiotherapy vs additional time to nearest radiotherapy centre



Discussion

This study did not show any significant effects of travel time to a radiotherapy centre on the proportion of patients receiving radiotherapy. The logistic regression models indicated little change in the proportion of patients being treated with radiotherapy with increasing travel time. The models also showed that the relationship between radiotherapy treatment rates and travel time was not statistically significant.

Statistically significant relationships were present with the other variables in the multivariate models – age and deprivation – indicating that these were more strongly associated with treatment undertaken than travel time.

This analysis focused on radiotherapy as it was considered that the multiple visits required for treatment would amplify any effects correlated with travel time, if present. It is possible that other factors associated with radiotherapy may be confounding the results. Future work may need to examine other types of treatment or perhaps analyse travel times and curative treatment rates more generally. Future work could also be expanded to investigate travel time effects for other cancer sites.

Acknowledgment

This work uses data provided by patients and collected by the NHS as part of their care and support.

References

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Appendix

Results

Proportion treated with radiotherapy vs travel time to radiotherapy centre.

Table 1: Radiotherapy proportion vs travel time to radiotherapy centre in ten minute intervals

Time (mins)	Radiotherapy	All patients	RT (%)	CI lower (%)	CI upper (%)
0 - 9	2,815	10,752	26.2	25.3	27.0
10 - 19	5,436	20,333	26.7	26.1	27.3
20 - 29	4,710	17,642	26.7	26.0	27.4
30 - 39	2,229	8,299	26.9	25.9	27.8
40 - 49	495	1,939	25.5	23.5	27.5
50 - 59	172	593	29.0	25.5	32.6
60 - 69	91	311	29.3	24.2	34.2
70 - 79	45	119	37.8	29.8	45.8
80 - 89	37	161	23.0	16.0	30.3
90 - 99	37	175	21.1	14.7	27.8
100 - 109	4	37	10.8	0.0	26.3

Proportion treated with radiotherapy vs additional time to radiotherapy centre.

Table 2: Radiotherapy proportion vs additional time to radiotherapy centre in ten minute intervals

Time (mins)	Radiotherapy	All patients	RT (%)	CI lower (%)	CI upper (%)
0 - 9	9,174	34,644	26.5	26.0	26.9
10 - 19	4,254	15,968	26.6	26.0	27.3
20 - 29	1,962	7,317	26.8	25.8	27.8
30 - 39	410	1,418	28.9	26.6	31.3
40 - 49	113	390	29.0	24.5	33.5
50 - 59	37	174	21.3	14.8	28.0
60 - 69	56	116	48.3	40.0	56.4
70 - 79	37	170	21.8	15.0	28.5
80 - 89	28	164	17.1	10.3	23.7

Proportion with radiotherapy as first treatment vs travel time to radiotherapy centre

Table 3: Radiotherapy as first treatment proportion vs travel time to radiotherapy centre in ten minute intervals

Time (mins)	Radiotherapy	All patients	RT (%)	CI lower (%)	CI upper (%)
0 - 9	2,297	10,752	21.4	20.6	22.1
10 - 19	4,494	20,333	22.1	21.5	22.7
20 - 29	3,884	17,642	22.0	21.4	22.6
30 - 39	1,831	8,299	22.1	21.2	23.0
40 - 49	413	1,939	21.3	19.4	23.2
50 - 59	143	593	24.1	20.9	27.6
60 - 69	74	311	23.8	19.1	28.5
70 - 79	39	119	32.8	25.1	40.2
80 - 89	28	161	17.4	11.2	24.2
90 - 99	31	175	17.7	11.7	24.3
100 - 109	4	37	10.8	0.0	25.3

Proportion with radiotherapy as first treatment vs additional time to radiotherapy centre

Table 4: Radiotherapy as first treatment proportion vs additional time to radiotherapy centre in ten minute intervals

Time (mins)	Radiotherapy	All patients	RT (%)	CI lower (%)	CI upper (%)
0 - 9	7,531	34,644	21.7	21.3	22.2
10 - 19	3,510	15,968	22.0	21.3	22.6
20 - 29	1,639	7,317	22.4	21.5	23.4
30 - 39	329	1,418	23.2	21.0	25.4
40 - 49	97	390	24.9	20.9	29.1
50 - 59	32	174	18.4	12.2	24.8
60 - 69	48	116	41.4	33.8	49.3
70 - 79	30	170	17.6	11.4	24.3
80 - 89	22	164	13.4	6.9	20.3

Radiotherapy providers

Table 2: Identified radiotherapy providers

PROV. CODE	PROVIDER NAME	POSTCODE	STARTDATE	ENDDATE
RA203	ST LUKES HOSPITAL	GU2 7XX		31-Mar-04
RA281	ROYAL SURREY COUNTY HOSPITAL HAEMATO-ONCOLOGY	GU2 7XX	01-Apr-04	
RA710	BRISTOL HAEMATOLOGY AND ONCOLOGY CENTRE	BS2 8ED		
RA901	TORBAY HOSPITAL	TQ2 7AA		
RAJ01	SOUTHEND HOSPITAL	SS0 0RY		
RAL01	ROYAL FREE HOSPITAL	NW3 2QG		
RBA11	MUSGROVE PARK HOSPITAL	TA1 5DA		
RBV01	THE CHRISTIE	M20 4BX		
RD130	ROYAL UNITED HOSPITAL	BA1 3NG		
RD300	POOLE GENERAL HOSPITAL	BH152JB		
RDEE4	COLCHESTER GENERAL HOSPITAL	CO4 5JL		
REF12	ROYAL CORNWALL HOSPITAL (TRELISKE)	TR1 3LJ		
REN20	CLATTERBRIDGE CENTRE FOR ONCOLOGY	CH634JY		
RF4OC	OLDCHURCH HOSPITAL	RM7 0BE		30-Sep-06
RF4QH	QUEEN'S HOSPITAL ROMFORD	RM7 0AG	01-Oct-06	
RGN80	PETERBOROUGH DISTRICT HOSPITAL/EDITH CAVELL	PE3 9GZ		
RGQ02	THE IPSWICH HOSPITAL NHS TRUST	IP4 5PD		
RGT01	ADDENBROOKE'S HOSPITAL	CB2 0QQ		
RH801	ROYAL DEVON & EXETER HOSPITAL (WONFORD)	EX2 5DW		
RHM01	SOUTHAMPTON GENERAL HOSPITAL	SO166YD		
RHM02	ROYAL SOUTH HANTS HOSPITAL	SO140YG		31-Dec-05
RHQWP	WESTON PARK HOSPITAL	S10 2SJ		
RHU03	QUEEN ALEXANDRA HOSPITAL	PO6 3LY		
RHW01	ROYAL BERKSHIRE HOSPITAL	RG1 5AN		
RJ121	GUY'S AND ST THOMAS' HOSPITAL	SE1 9RT		
RJE01	NORTH STAFFORDSHIRE ROYAL INFIRMARY	ST4 7LN		
RJE21	CITY GENERAL HOSPITAL ONCOLOGY (STOKE-ON-TRENT)	ST4 6QG		
RK950	DERRIFORD HOSPITAL	PL6 8DH		
RKB01	UNIVERSITY HOSPITAL (COVENTRY)	CV2 2DX		
RL403	NEW CROSS HOSPITAL	WV100QP	01-Apr-09	
RM102	NORFOLK & NORWICH UNIVERSITY HOSPITAL	NR4 7UY		
RN506	BASINGSTOKE AND NORTH HAMPSHIRE HOSPITAL	RG249NA		
RNJM0	ST BARTHOLOMEW'S HOSPITAL	EC1A7BE		
RNLAY	CUMBERLAND INFIRMARY	CA2 7HY		
RNS01	NORTHAMPTON GENERAL HOSPITAL (ACUTE)	NN1 5BD		
RPANM	NORTH MIDDLESEX UNIVERSITY HOSPITAL	N18 1QX		
RPY01	THE ROYAL MARSDEN HOSPITAL (LONDON)	SW3 6JJ		
RPY02	THE ROYAL MARSDEN HOSPITAL (SURREY)	SM2 5PT		
RR803	COOKRIDGE HOSPITAL	LS166QB		31-Dec-08
RR813	ST JAMES'S UNIVERSITY HOSPITAL	LS9 7TF		
RRK90	QUEEN ELIZABETH HOSPITAL ONCOLOGY (BIRMINGHAM)	B15 2TH		
RRV03	UNIVERSITY COLLEGE HOSPITAL LONDON	NW1 2BU	01-Apr-05	
RRV20	MIDDLESEX HOSPITAL	W1T 3AA		31-Mar-05
RTD06	NORTHERN CENTRE FOR CANCER CARE	NE7 7DN		
RTE01	CHELTENHAM GENERAL HOSPITAL	GL537AN		
RTE83	HEREFORD COUNTY HOSPITAL	HR1 2ER	01-Jan-14	
RTGFG	ROYAL DERBY HOSPITAL	DE223NE	01-Jan-11	
RTH02	CHURCHILL HOSPITAL	OX3 7LJ		
RTH08	JOHN RADCLIFFE HOSPITAL	OX3 9DU		
RTRAT	JAMES COOK UNIVERSITY HOSPITAL	TS4 3BW		
RVVE6	KENT & CANTERBURY HOSPITAL	CT1 3NG	01-Nov-10	
RWA02	PRINCESS ROYAL HOSPITAL	HU8 9HE		31-Jul-08
RWA16	CASTLE HILL HOSPITAL	HU165JQ	01-Aug-08	
RWDBM	ST GEORGES HOSPITAL	LN1 1FS		30-Sep-02
RWDDA	LINCOLN COUNTY HOSPITAL	LN2 5QY		
RWE07	LEICESTER ROYAL INFIRMARY ONCOLOGY AND HAEMATOLOGY	LE1 5WW		
RWF03	MAIDSTONE DISTRICT GENERAL HOSPITAL	ME169QQ		
RWH04	MOUNT VERNON CANCER CENTRE	HA6 2RN		
RWP50	WORCESTERSHIRE ROYAL HOSPITAL	WR5 1DD	01-Jan-15	
RX1ON	CITY ONCOLOGY (NOTTINGHAM)	NG5 1PB		
RXH01	ROYAL SUSSEX COUNTY HOSPITAL	BN2 5BE		
RXN02	ROYAL PRESTON HOSPITAL	PR2 9HT		
RXWAS	ROYAL SHREWSBURY HOSPITAL	SY3 8XQ	01-Jan-10	
RYJ02	CHARING CROSS HOSPITAL	W6 8RF		
RYJ03	HAMMERSMITH HOSPITAL	W12 0HS		